Development of a decision support system for banana pest management

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Abstract

As part of artificial intelligence technology, decision support systems have been recognized as a powerful tool to store human knowledge in computers for the purpose of making expert's knowledge available to users. Therefore, there are very good reasons to explore the possibilities of developing information and decision support system in agriculture. The present study is an attempt to design a decision support system for plant protection taking banana as the principal crop. The software development activities were carried out in five stages. During the first stage the decision making situation was studied in depth. This was followed by developing the prototype design and operationalization of variables. The database was developed in the third stage. The software design was completed and validated in the fourth stage. The final validation of the tool with the end users was done at the final stage. And the final software was made available in the domain www.farmextensionmanager.com

Key words: Pest doctor, Decision support system, Farm extension manager

Introduction

Agricultural production has evolved into a complex business requiring the accumulation and integration of knowledge and information from many diverse sources. In order to make prudential, accurate and rational decisions, farm managers need speedy access to advice on agricultural problems, which should be timely, reliable and consistent. As part of artificial intelligence technology, decision support systems have been recognized as a powerful tool to store human knowledge in computers for the purpose of making expert's knowledge available to users (Waterman, 1986). Therefore, there are very good reasons to explore the possibilities of developing information and decision support system in agriculture (Sunil, 2006).

In designing decision support systems, knowledge forms the key component. The way knowledge is collected, synthesized and represented mainly explains the acceptability of the system. Hence, proper insight into the user behaviour during decision-making is very much important. In the same way, questions on how to assess the appropriateness of these systems for their intended purposes have to be adequately looked into. Therefore, how best a decision support system can be developed and validated formed the major issue before extension. And in the present study an attempt to design a decision support system for plant protection was undertaken taking banana as the principal crop.

Materials and Methods

Banana was selected as the principal crop for the study based on its extensive cultivation and commercial orientation. The annual life cycle, the heterogeneous growing environment and the

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distributed cultivation are other factors considered. The study was conducted in the state of Kerala. The required data was collected through conventional and participatory methods from the three groups of respondents, namely farmers, extension personnel and research scientists.

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Result and Discussion

A. Analysis of the decision making situation

Plant protection literally means guarding the plant against internal and external agents that can cause harm to it. In banana, fungus, virus, bacteria, insects and nematodes form the major biotic factors that cause damage. On the other side, there are nutritional disorders and environmental problems that many a time warrant effective management strategy. A total of more than 100 plant protection problems were reported in banana from India with different degrees of intensity of infestation. Therefore, the decision-making situation in which the farmer operates was considered highly complex. In this complex situation the most common problem the farmers face was to distinguish between symptoms and their causes. This happens because most problems overlap with one another in their symptoms. Most farmers fail to correctly diagnose disease damage from insect damage. Hence, an innovative approach to make the diagnostic process correct was found necessary and was attempted through the pest doctor.

B. Design of a prototype model for the tool

The important plant parts of banana include the rhizome, pseudostem, leaves and the bunch. The symptoms of these problems definitely occur in any one of the listed parts or in more than one part. Similarly, such variables like colour, form / appearance, movements, smell, etc. form the basic elements of human perception.

The discolouration can be internal or external. Similarly, the colour itself can have many variations. Defects in shape or deformation vary from reduction in size to thickening, cupping, crinkling etc. Another type of symptom is the unusual appearance of spots and streaks. The movements of insects and their young ones is yet another way to diagnose problems. Besides there can be physical damage like uprooting, toppling or tearing of leaf. In the plant - human communication process, there is every chance to notice these elements.

Developing a model merging these two components will definitely improve the diagnostic power of the users. Hence, a prototype model was designed in the line of the Pest Doctor developed by International Rice Research Institute (Fig.1).

The procedure of working of the model follows an inverted tree logical reasoning structure. The model first asks the respondents to select the plant part on which the problem is noticed from the first rectangular box. And the choices presented before him include rhizome, pseudostem, leaves, bunch and whole plant. The choices represent the common plant parts of a banana plant.

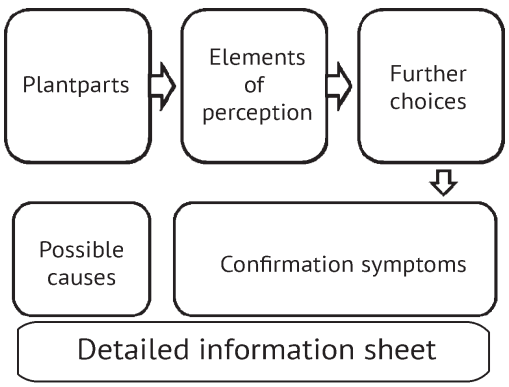

Figure 1. Prototype design of the pest doctor

When the user makes a selection from the first rectangular box, he will be opened to the second rectangular box. The second rectangular box contains the common symptoms noticed as a result of infestation. The common symptoms were derived from the basic elements of visual perception through expert consultation. The identified elements include: change in colour, defects in shape, physical damage, insect movement, unpleasant smell and reduction in size. These choices are common to all plant parts. However, in cases when the common symptoms are not represented in a particular plant part, the same is hidden.

On selecting the common symptoms, the third rectangle will come to the right of the second one. But in this case, the options are different, and will be decided by the choices at the second rectangle. Selection of an option from this rectangle is also mandatory to make the diagnosis process work.

Once the user answers all the three questions in the decision tree he will be presented with all the possible reasons of the problem and also their conformational symptoms. The "Possible Reasons" will be arranged in the order of their chances of severity of occurrence. And in the second part of the box, the most critical conformational symptoms will be included.

The final diagnosis of the problem will be left to the user. He has to make the diagnosis from the "Possible Reasons" given to him using the "Conformational Symptoms". And, once he does the job, he will be automatically taken to the problem information sheet. And the problem information sheet will give complete details of the selected problem.

C. Preparation of database for the tool

The database for the tool was prepared in a sequence of three stages. In the first stage all the plant protection problems of banana were identified. The various literature on this regard and the help of experts were sought for this purpose. A total of 98 problems were identified during the process.

The problems thus identified were thereafter rated for their severity in banana cultivation with a group of ten experts. The rating was done on a continuum starting from severe, to occasional and rare with two marks for severe and zero for rare occurrence. All those problems that obtained a score above five were selected. The problems thus identified were thereafter checked for symptoms and management strategy. Problems with similar symptoms and management strategy were grouped together. Thus at the end, only twenty-four plant protection problems were identified to be included in the system.

During the next stage the decision matrix was developed to classify the plant protection problems in accordance with the identified characters. The data for the same was collected from Banana Research Station, Kannara and National Research Centre for Banana, Tiruchirapalli. Classification was done after consultation with experts and also based on various publications.

In the final stage, the conformation symptoms for each plant protection problem were identified to represent key features in the exposed plant parts. The identified conformation symptoms were corrected with experts working in the field.

D. Development of software materials

Software development is the conversion of the theoretical design to computer design. The development of software was done in such a way so as to work both in offline and online modes. Based on the analysis of data structure, it was found necessary to develop the software in three basic layers (Fig. 2). The three basic layers include the user side interface layer, the business logic layer and the database layer at the bottom.

The user side interface layer represents the layer of the programme that appears in front of the user. The user interface was designed using FLASH and

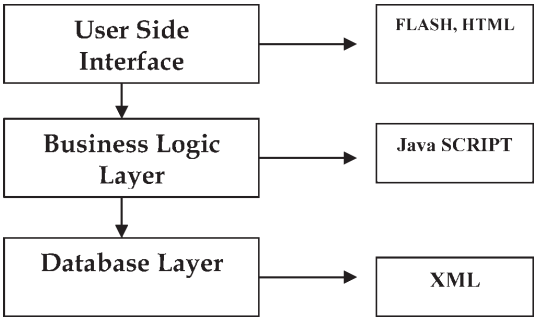

Figure 2: Basic Architecture of the Software Design

Hyper Text Markup Language. The business logic layer acts as the connecting link between the database layer and client side interface layer. The request from the users are processed and replied to through this layer. The business logic application layer for the programme was developed through Java script. Database layer represents the area where the basic data to be used by the system was stored. The data base layer for the system was developed in XML language.

The software thus developed was tested in three stages. During the first stage the working of the programme was tested. In the second stage, the language parts of the software were checked for spelling and grammatical errors. In the third stage, the programme was used in different computers with different operating systems to evaluate its working. The problems noticed were rectified every now and then. And the final software was made available in the domain www.farmextensionmanager.com

E. Final testing and validation of the tool

The final testing of the interactive tool was done in four steps. The respondents were first asked to write ten common plant protection problems of banana that were severe in their locality and their symptoms. Then, they were asked to diagnose those problems using the tool and find the result. Hereafter, the respondents were given the scale containing five dimensions and were asked to rate the system. The overall score of all the respondents were added and averaged to get the final result of testing.

Table 1. Results of the testing of the pest doctor with users

Sl. No	Dimensions	Average Score out of 10
1	Adaptability	8.42
2	Accuracy	8.48
3	Relevance	8.62
4	Interactivity	8.58
5	Utility	8.34
	Average of all dimensions	8.49

The results of the testing of the interactive tool on pest doctor are presented in Table 1. The results showed an overall average score of 84.90 per cent with a very high rating of 86.20 per cent for the dimension relevance. The result validated the relevance of the tool.

The study presented a new method of developing decision support system in agriculture. Instead of discussing the insect problems, fungal problems and nutritional and physiological problem separately, the tool tried to bring a holistic approach in pest management. Further, the basic concept in perception was effectively taken care of in the diagnostic process.

The pest doctor was developed adopting five step development processes. The developed software was tested for its acceptability under various heads. The result validated the relevance of the tool. The users of the system can improve their pest management skills with the new software.

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